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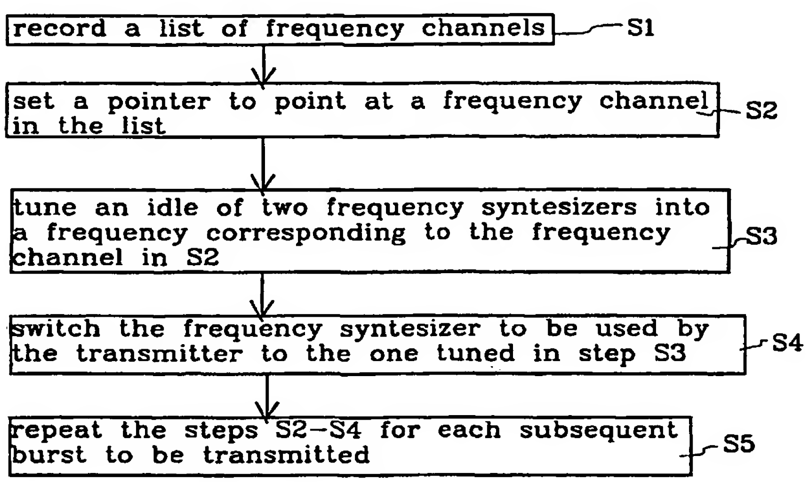
(54) Title: RADIO TRANSMITTER SYSTEM, RADIO RECEIVER SYSTEM, AND METHODS RELATED TO FREQUENCY HOPPING



(57) Abstract: The present invention is related to a frequency hopping TDMA rado transmission system and enables frequency hopping to be performed for subsequent timeslots within the same TDMA-frame. It is directed to a transmitter, a receiver, a method for transmitting and a method for receiving. According to the invention a frequency channel to hop on is selected by means of a pointer that is set to point at a new frequency channel in a list of frequency channels. For each subsequent burst to be transmitted a new frequency channel is selected. Two frequency synthesizers are alternately tuned into the selected frequency channel and alternately used by the transceiver for transforming a base band burst to the radio frequency channel.

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RADIO TRANSMITTER SYSTEM, RADIO RECEIVER SYSTEM, AND METHODS RELATED TO FREQUENCY HOPPING

TECHNICAL FIELD OF THE INVENTION

The present invention relates to Frequency Hopping in a TDMA radio system. More in detail the invention relates to a radio transmitter system, to a method related to such a system, to a radio receiver system and to a method related to such a system

DESCRIPTION OF RELATED ART

In a radio communication system based on TDMA (Time Division Multiple Access) technology a radio frequency channel is divided into timeslots. An example of the frequency channel FCH, and timeslots TS are shown in figure 1. A number of subsequent timeslots TS are grouped into a TDMA-frame and thus the frequency channel FCH is divided into a number of subsequent TDMA-frames. Each TDMA-frame comprises a well defined number of timeslots TS, in the well known cellular radio system GSM a TDMA-frame comprises 8 timeslots TS, each given a timeslot number from 0 to 7. A radio burst is a period of transmission of a data stream on the frequency channel. The radio burst must be sent within a timeslot TS and just one burst fits into a timeslot TS.

The radio interface of many cellular radio systems working according to the TDMA principle, uses slow frequency hopping. Thereby, the frequency channel FCH1-FCH4 used for the transmission is switched for subsequent transmitted TDMA-frames F1-F5, see figure 2.

A Basic Physical Channel BPC, BPC3, BPC4 is allocated a certain timeslot TS number that is repeated in each subsequent TDMA-frame. In figure 1, this is shown for a non-frequency-hopping system.

In figure 2, four frequency channels FCH1-FCH4 are used for frequency hopping. Consequently, in the frequency hopping system, the certain timeslot TS number that is allocated to a Basic Physical Channel BPC3, BPC4 changes frequency channel FCH1-FCH4. One radio transmitter can transmit a maximum of eight Basic Physical Channels BPC3, BPC4 that are grouped into subsequent TDMA-frames. A switch of frequency channel FCH1-FCH4 is made for each subsequent TDMA-frame sent from the transmitter. The TDMA-frames sent by the transmitter is allocated to a group of radio frequency channels and is frequency hopping on the radio frequency channels of the group according to a predefined pattern. The a group of radio frequency channels is hereafter called Hopping Frequency Set HFS.

On the radio link, a traditionally speech connection comprises a Basic Physical Channel BPC in uplink and downlink respectively, the up- and downlink using separate frequency channels FCH. By uplink is meant the direction from a mobile terminal to a fixed base transceiver station and by downlink is meant the opposite direction from a fixed base transceiver station to a mobile terminal. The traditional uplink channel and downlink channel are separated by a fixed frequency separation, the duplex separation. Thus, the uplink and downlink channel pair of a frequency hopping duplex channel must use the same frequency hopping sequence.

In TDMA cellular systems, channel coding and interleaving enables signal detection to correct or decrease the influence of corrupted signals on condition that the amount of corrupted signals are at reasonable level. Frequency

hopping used in combination with channel coding and interleaving further improves the signal detection. The reasons are frequency diversity and interferer diversity. In a cell, one or more of the frequencies channels used for frequency hopping may be severely exposed to interference while the remaining frequencies are not effected. Moreover, for a specific communication link with a mobile at some of the frequencies of the cell may experience a deep fading dip at the location of the mobile station or base transceiver station. By hopping over several frequency channels the adversely effect experienced on some of the frequency channels FCH1-FCH4 are spread over all Basic Physical Channels used and thereby made possible for the channel coding to correct.

US 5,648,967 is mainly concerned about channel coding and also shortly describes the principle of slow frequency hopping and the benefits of frequency hopping on timeslot basis. However, US 5,648,967 do not describe how the frequency hopping is generated in the radio transmitter or receiver.

For the well known cellular radio system GSM the technical specification GSM 05.02 version 8.2.0, chapter 5.4 specifies that frequency channel may solely be changed between transmission of TDMA-frames. Thus, frequency hopping is not made during the transmission of a TDMA frame.

SUMMARY OF THE INVENTION

One aspect of the present invention is to address the problem of how to enable frequency hopping on timeslot basis in a radio transmission system.

The problem is solved by a radio transmission system that comprises a transmitter arranged to transmit radio bursts in consecutive timeslots and two frequency synthesizers that are connected to the transmitter. The radio transmission

system further comprises a list of available radio frequency channels, means for selecting radio frequency channel from the list by setting a pointer to point at a new radio frequency channel for each burst to be sent and means for controlling said frequency synthesizers to alternately tune into a High Frequency corresponding to the selected radio frequency channel. The transmitter has an input for receiving bursts and is arranged to use a High Frequency generated by an alternating of the frequency synthesizers to transform each burst to the selected radio frequency channel and be transmitted as a radio burst

The problem is also solved by a method selecting a radio frequency channel from a list by setting a pointer to point at a radio frequency channel in the list for each burst to be sent in a subsequent timeslot.

Another aspect of the present invention is to address the problem of how to enable frequency hopping on timeslot basis in a radio receiving system. The problem is solved by a receiving system having all the features of the transmission system but with the transmitter exchanged to a receiver.

The problem is also solved by a method for receiving bursts on alternating a radio frequency channel by determining the radio frequency channel for the next burst to be received by setting a pointer according to a predefined algorithm to point at a radio frequency channel in a list of possible radio frequency channels for each burst to be received.

An advantage of the invention is that it further improves the advantages of frequency hopping on TDMA-frame basis.

Frequency hopping according to the present invention have an advantage similar to that of interleaving, and that is to improve correct detection of data in a receiver when some of the data is corrupted on the radio link. This is achieved by spreading in time the corrupted data. For interleaving this

is made by scrambling in time a consecutive stream of data into a non-consecutive stream to be sent over the radio channel. In the receiver the data stream is reordered into the consecutive stream and temporarily loss of data will then effect data bits spread out over the consecutive stream. For frequency hopping, the spreading refers to the fact that some but not all of the frequency channels used for hopping may be vary bad due to severe radio conditions on one or more particular frequency channel. Only data in timeslots sent on the bad radio channel will be corrupted and since consecutive timeslots are sent on different frequency channels adjacent timeslots to one lost will be correctly received. Thereby, if coding is used, the short loss of data, due to a bad frequency channel can be recovered by the data received over the rest of the frequency channels.

Therefore, frequency hopping on timeslot basis according to the present invention can be used instead interleaving. The invention provides a further improvement compared to interleaving, and that is to avoid time delays imposed by interleaving, where a greater interleaving depth imposes a longer delay.

Of cause, the present invention can also be used even if no radio coding is added to the transmitted data. For such conditions, an advantage of the present invention is to give equal radio transmission quality to a plurality of users.

The present invention is alternatively used in combination with interleaving and coding and then has the advantage of further improving correct detection of data corrupted over the radio channel.

The improvement of correctly detection of data in the receiver results in the further benefit of less data need be

retransmitted and thereby increase in data transmission rate on the radio link.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a prior art diagram illustrating the TDMA-principle applied on a radio frequency channel.

Figure 2 is a prior art diagram illustrating the principle of frequency hopping in a TDMA-system.

Figure 3 is a view of a cellular radio system.

Figure 4 is a list of frequency channels from which frequency channels are selected for frequency hopping.

Figure 5 is a diagram illustrating the principle of the frequency hopping enabled by the present invention.

Figure 6 is a flow chart of a method according to the present invention related to a transmitter.

Figure 7 is a block diagram on a frequency hopping transmission system, according to the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 shows the principle of TDMA (Time Division Multiple Access) for the radio interface. A radio frequency channel FCH, hereafter just frequency channel, is divided into timeslots TS. The timeslots TS are grouped into TDMA-frames. In the GSM-system a TDMA frame comprises 8 timeslots TS. The timeslots TS within each TDMA-frame are numbered. In a non-frequency-hopping GSM-system, a timeslot TS, for example timeslot TS number 3, repeated in each TDMA-frame on the frequency channel FCH is allocated to a Basic Physical Channel BPC. Information on the Basic Physical Channel BPC is transmitted as bursts in the corresponding timeslots.

In a frequency hopping GSM-system, as showed in figure 2, to a Basic Physical Channel BPC3, BPC4 is also allocated a specific timeslot number repeated in subsequent TDMA-frames. However, the frequency channel FCH1-FCH4 used is altering for the subsequent TDMA-frame numbers F1-F5 according to a predefined hopping sequence. For the sake of simplicity, just 4 frequency channels FCH1-FCH4 are shown in figure 2 for frequency hopping, but more or less than 4 channels can also be used.

In figure 2, are showed two Basic Physical Channels BPC3, BPC4 in adjacent timeslots TS using the same frequency channel FCH1-FCH4. They are both dedicated for the communication with a multi-slot mobile station MS1. If one of the frequency channels FCH1-FCH4 are exposed to interference or experiences a fading dip at the position of the mobile station MS1, both timeslots within a TDMA-frame are affected.

To a whole GSM-system a large number of radio frequency channels FCH1-FCH4 are allocated. The total number of frequency channels FCH1-FCH4 is split into channel groups with a set of frequency channels FCH1-FCH4 each.

A geographical area served by a mobile radio system is divided into cells C1-C3. Figure 3 shows the geographical area divided into a cellular pattern. To each cell C1-C3 is allocated a channel group. A base transceiver station BTS, located in a first cell C1 serves mobile stations located within the first cell C1 with communication service, for example the mobile station MS1. A radio link in the direction from the base transceiver station BTS to the mobile station MS1 is called downlink and the opposite direction from the mobile station MS1 is called uplink. Traditionally, speech has been the main service and just one Basic Physical Channel in up and downlink respectively has been assigned for the communication with the mobile station

MS1. However, a multislot mobile station MS1 handles communication over more than one Basic Physical Channel BPC.

In order to reduce the impact of co-channel interference and adjacent channel interference, the allocation of channel groups to the cells C1-C3 is carefully planned. The plan is made to avoid adjacent radio frequency channels FCH1-FCH4 to be allocated adjacent cells and to reuse radio frequency channels FCH1-FCH4 in cells that are spaced apart by a minimum number of cells in between.

In figure 4 is shown a list HFS of frequency channels FCH1-FCH4 that are allocated to a cell C1-C3, for example the first cell C1. The list HFS is called Hopping Frequency Set in the further description. The Hopping Frequency Set HFS is a subgroup of the channel allocation group and comprises the frequency channels FCH1-FCH4 used for frequency hopping within the cell C1.

In figure 4 is also shown a pointer MAI pointing at the first position in the Hopping Frequency Set HFS containing the first frequency channel FCH1. A transmitter TRX1-TRX2, shown in figure 7, transmits subsequent TDMA-frames. These subsequent TDMA-frames are all associated with one corresponding pointer MAI that selects a frequency channel FCH1-FCH4 to be used for the transmission of a TDMA-frame by pointing at a position in the Hopping Frequency Set HFS.

In figure 4 is also indicated a Mobile Allocation Index Offset MAIO that defines the offset from the position in the Hopping Frequency Set HFS that would be pointed out by the frame number FN only.

The GSM specification 05.02 version 8.2.0 chapter 6.2.3 describes Hopping Sequence Generation in general. The specification defines that for cyclic frequency hopping the pointer MAI is set to point at a position according to the algorithm:

MAI=(FN+MAIO) Modulo N (A)

Parameter FN denotes the TDMA-frame number, MAIO the Mobile Allocation Index Offset and N is the number of frequency channels FCH1-FCH4 in the Hopping Frequency Set HFS. The pointer MAI is set to point at a new position in the Hopping Frequency Set HFS for each subsequent TDMA-frame number F1-F5. Thereby a new frequency channel FCH1-FCH4 is selected for each subsequent TDMA-frame to be sent by the transmitter TRX1-TRX2.

As an example, let the pointer in figure 4 be associated with the repetitive TDMA-frame in figure 2 that comprises the Basic Physical Channel BPC3, BPC4 indicated.

At start the TDMA-frame has frame number F1 1, i.e. FN=1 in (A), the Mobile Allocation Index Offset MAIO is set to 0 and thus the pointer MAI in figure 4 points at the first frequency channel FCH1. The TDMA-frame is thus sent on the first position in the Hopping Frequency Set containing the first frequency channel FCH1 in the first TDMA frame number F1. At the next TDMA-frame number F2, FN is 2, the Mobile Allocation Index Offset MAIO remains at 0 and the pointer MAI is thereby set to point at the frequency channel FCH2 in the second position in the Hopping Frequency Set HFS.

In figure 5 is shown frequency hopping made within the TDMA-frames between subsequent time slots TS. Two Basic Physical Channels BPC3, BPC4 are allocated to the communication with the first multi-slot mobile station MS1. One of the Basic Physical Channels BPC3 uses timeslot TS No. 3 in each TDMA-frame and here are called the third Basic Physical Channel BPC3, and consequently timeslot TS No. 4 is allocated to the fourth Basic Physical Channel BPC4. They are thus allocated to adjacent timeslots TS but use separate frequency channels FCH within each TDMA-frame. It is an object of the present

invention to enable frequency hopping within the same TDMA-frame when transmitted by one transmitter.

According to one aspect of the present invention, a modified version of algorithm (A) is:

$$MAI = (FN + Z + MAIO) \text{ Modulo } N \qquad (B)$$

Parameter Z in algorithm B denotes the timeslot TS number in the TDMA-frame, the rest of the parameters being the same as in algorithm (A). As the timeslot TS number is changed for each subsequent timeslot TS in a TDMA-frame, parameter Z increases by one, and thus the pointer MAI is set to point at a new frequency channel FCH1-FCH4 for each subsequent timeslot TS, and the subsequent timeslots TS are being transmitted on different frequency channels FCH.

Alternatively to the use of parameter Z, the Mobile allocation index offset MAIO is set to a timeslot TS specific value for each timeslot TS within a TDMA-frame, and thus the pointer MAI is changed for subsequent timeslots TS resulting in a frequency hopping as showed in figure 5.

A further alternate aspect of the invention is to provide 8 Hopping Frequency Sets HFS, each associated with a corresponding of the timeslot TS numbers. For the first timeslot TS number, i.e. number 0, the first of the Hopping Frequency Sets HFS is used.

In case the transmission system comprises more than one transmitter, and thereby at least two timeslots TS will be sent in parallel on different frequency channels FCH1-FCH4, a pointer MAI is associated with each of the parallel timeslots TS. The pointers MAI point at separate positions in the first Hopping Frequency Set HFS and thereby selects different frequency channels FCH1-FCH4 by means of separate Mobile Allocation Index Offsets MAIO.

Figure 5 will now be further described with reference to the first aspect of the invention and algorithm (B). The third Basic Physical Channel BPC3 is allocated timeslot TS number 3, i.e. Z=3, the Mobile Allocation Index Offset MAIO is set to 0, the number of the first TDMA-frame number F1 is 1, i.e. FN=1, the number N of frequency channels FCH1-FCH4 is 4 and according to algorithm (B) the pointer MAI is thus set to:

(1+3+0) Modulo 4 = 4

At position 4 in the Hopping Frequency Set HFS the fourth frequency channel FCH4 is stored. Thus BPC3 is to be sent on the fourth frequency channel in the first TDMA-frame F1. For the next TDMA-frame number F2, all parameters remains the same except for FN=2. Pointer MAI is thus set to 1 according to algorithm (B) and thereby points at position 1 in the Hopping Frequency Set where the first frequency channel FCH1 is stored. Thereby the first frequency channel FCH1 is selected for transmission of the third first basic physical channel BPC3.

The fourth Basic Physical Channel BPC4 is allocated to timeslot TS number 4, and thus parameter Z is set to 4, all other parameters being the same as for the third Basic Physical Channel BPC3 in algorithm (B). This results in the pointer MAI being assigned to 1 and thereby the first frequency channel FCH1 is selected. The two Basic Physical Channels will always use frequency channels separated by offset 1 in the same TDMA-frame number F1-F5.

In figure 6 a flow chart of the steps of an inventive method is shown. The method is intended for use in a transmitter system including a transmitter for transmission of bursts in subsequent timeslots and two frequency synthesizers alternately generating a High Frequency for the transmitter.

In the first step S1 a list of frequency channels FCH1-FCH4, i.e. a Hopping Frequency Set HFS, is recorded. This is typically made in the base transceiver station BTS by the operator of the GSM system when a new frequency plan is adopted. The Hopping Frequency Set HFS comprises a number of positions each containing a Frequency Channel FCH1-FCH4.

In a following step S2, a pointer (MAI) is set to point at a Frequency Channel FCH1-FCH4 in the Hopping Frequency Set HFS.

According to a next step S3, an idle one of two frequency synthesizers is set to generate a High Frequency corresponding to the Frequency Channel FCH1-FCH4 pointed at in step S2.

In the following step S4, the one of the two frequency synthesizer to be used by the transmitter is switch to the one tuned in step S3.

According to the last step S5, steps S2-S4 is repeated for each timeslot.

In figure 7 a base transceiver station BTS is shown, however only parts essential for describing the present invention is shown. It comprises an interface I/O, towards a Base Station Controller BSC, connected to a signal processing unit SPU that is connected to 2 transceiver units TRX1-TRX2. The transceiver units TRX1-TRX2 are connected to an antenna AA. To each of the transceivers TRX1-TRX2 two frequency synthesizers FS11-FS22 are connected to deliver a stable High Frequency. The base transceiver station BTS also includes a control unit CNTL, that controls the interface unit I/O, the signal processing unit SPU, the transceivers TRX1-TRX2 and the frequency synthesizers FS11-FS22 by sending control commands over two control buses BS1, BS2.

The signal processing unit SPU receives in the downlink streams of digital data that are to be sent over corresponding Basic Physical Channels BPC over the air interface. The signal processing unit SPU transforms the digital streams to corresponding analogue base band streams of bursts.

Each of the transceivers TRX1-TRX2 is fed by the signal processing unit SPU with streams of analogue base band burst corresponding to a maximum of eight Basic Physical Channels BPC. The transceivers TRX1-TRX2, for example the first transceiver TRX1, modulates the stream of baseband bursts, transforms each base band burst to the frequency channel FCH1-FCH4, amplifies the bursts and transmits them in consecutive timeslots TS.

The control unit CNTL includes a clock for synchronizing the units within the base transceiver station BTS and the transmission of bursts in corresponding timeslots TS. The control unit CNTL also includes a frequency hopping control part FHCT that in turn includes the Hopping Frequency Set HFS, for each transceiver TRX1-TRX2 a corresponding pointer MAI that selects a frequency channel FCH1-FCH4 in the Hopping Frequency Set HFS and a processor for switching the pointer MAI according to algorithm (B).

Alternatively frequency hopping control part FHCT includes a processor that switches the pointer MAI for each timeslot by means of timeslot number specific Mobile Allocation Index Offsets MAIO.

A further alternative is to include transceiver TRX1-TRX2 specific Hopping Frequency Sets HFS and a processor shifting the position of the pointer MAI for each timeslot TS in the frequency hopping control part FHCT.

The first transceiver TRX1 receives a High Frequency from an alternating of the two connected frequency synthesizers

FS11, FS12 for transforming the base band burst to the frequency channel FCH1-FCH4 selected. A switch of the frequency synthesizer FS11, FS12 to deliver a High Frequency is made at each timeslot TS. During the time the second of the frequency synthesizers generates a High Frequency for the first transceiver TRX1, the first frequency synthesizer FS11 is commanded to tune into the frequency channel FCH1-FCH4 selected by the pointer MAI, for the next timeslot TS. The first frequency synthesizer FS11 shall be tuned into a stable frequency corresponding to the selected frequency channel FCH1-FCH4 at the start of the next timeslot at which the transceiver TRX1 shifts reception of High Frequency from the second frequency synthesizer FS2 to the first frequency synthesizer FS1. While the first frequency synthesizer FS11 generates a stable frequency used by the transceiver TRX1, the second frequency synthesizer FS2 is tuned into High Frequency corresponding to a frequency channel selected by the pointer MAI for a next timeslot TS.

The frequency hopping control part FHCT thus selects frequency channel FCH1-FCH2 and commands the frequency synthesizers FS11, FS12 to tune into the corresponding frequency in advance of the next timeslot in order for the frequency synthesizer FS11, FS12 to generate a stable frequency at the beginning of the next timeslot TS. This is controlled by the frequency hopping control part FHCT.

There is a corresponding pointer MAI for each of the transceivers TRX1-TRX2. Both pointers MAI operates on the same Hopping Frequency Set HFS, but are assigned separate Mobile Allocation Index Offsets MAIO to avoid use of the same frequency channel FCH1-FCH4 for timeslots TS sent simultaneously.

The transceivers TRX1-TRX2 in figure 7 also comprise a receiver each. The frequency channels FCH1-FCH4 of the Basic Physical Channels BPC3, BPC4 to be received can be

determined according to the algorithm used for the frequency hopping, for example algorithm B provided the value of the parameters used in the algorithm are known. The parameter values are registered in a base transceiver station, by the operator setting the parameter values in the base transceiver station BTS. To the transceivers TRX1-TRX2 two additional frequency synthesizers are connected for alternately generating a High Frequency to the receiver. The receiver uses the High Frequency for downconverting a burst received in a frequency channel FCH1-FCH4 to a baseband burst. The two additional frequency synthesizers are, however, not shown in figure 7.

Also the mobile station MS1, in common with the base transceiver station BTS in figure 7, is provided with a transceiver TRX1, two frequency synthesizers FS11, FS12, for the up- and downlink respectively connected to the transceiver, a signal processing unit SPU and a control unit CNTL including a frequency hopping control part FHCT substantially arranged as described with reference to figure 7. One difference is though that instead of the connection to the Base Station Controller, there is a user interface. The mobile station MS1 thereby transmits and receives more than one Basic Physical Channel BPC3, BPC4 on different frequency channels FCH1-FCH4 within the same TDMA-frame. The mobile station MS1 determines the same frequency channels FCH1-FCH4 to be used by the Basic Physical Channels BPC3, BPC4 as the base transceiver station BTS determines by means of the same algorithm and the same parameters values being used. The algorithm and the parameter values are received by the mobile station MS1 in idle mode in the message System Information Message Type 1 on the BCCH-channel. The GSM specification also defines the messages for sending information necessary for the mobile station to determine the Frequency Hopping Sequence when handover to a new cell is made.

So far only cyclic frequency hopping has been described. The invention can also be applied in what is commonly referred to a as a pseudo-randomly frequency hopping system, which is a predefined hopping pattern that has a cycle over several minutes, typically six minutes. In such a system parameter FN in algorithms A and B is changed to a value that is changed for each TDMA-frame during the interval.

CLAIMS

1. A method related to a TDMA transmission system (BTS) that is arranged to transmit data in bursts and that includes a radio transmitter (TRX1-TRX2) and two frequency synthesizers (FS1,FS2) having outputs connected to the radio transmitter (TRX1-TRX2) and that are alternately used by the radio transmitter for transforming a received stream of bursts onto a radio frequency channel (FCH1-FCH4), the method including the steps of:

a) recording (S1) a list (HFS) of available radio frequency channels (FCH1-FCH4),

b) selecting (S2)a first radio frequency channel (FCH1-FCH4) from the list (HFS) of radio frequency channels, by setting a pointer (MAI) to point at a position in the list (HFS) containing the selected first radio frequency channel (FCH);

c) tuning (S3) an idle one of the two frequency synthesizers (FS11-FS22), into a frequency corresponding to the first radio frequency channel (FCH1-FCH4);

d) switching (S4) the frequency synthesizer (FS11-FS22) to be used by the transceiver into the one tuned in step c, thereby causing the next burst of the received stream to be transformed onto the first radio channel, and

e) repeating (S5) steps b to d for each subsequent burst to be transmitted and thereby causing subsequent bursts to be transmitted on an alternating radio frequency channel (FCH1-FCH4).

2. A method related to a TDMA receiving system (BTS) arranged to receive data in the form of bursts in corresponding timeslots (TS) and on alternating radio frequency channels (FCH1-FCH4), the receiving system including a

radio receiver (TRX1-TRX2) with inputs from two frequency synthesizers (FS11,FS22) alternately used for downconverting a received stream of radio burst to a stream of baseband bursts, the method including the steps of:

a) recording a list (HFS) of radio frequency channels (FCH1-FCH4), each at a corresponding position in the list;

b) determining on which radio frequency channel (FCH1-FCH4) a next burst will be received, by setting a pointer to point at a position in the list according to a predefined algorithm, wherein the radio frequency channel is found in the position;

c) tuning an idle one of the two frequency synthesizers into a frequency corresponding to the radio frequency channel (FCH1-FCH4) found in step b;

d) switching the frequency synthesizer to be used by the receiver (TRX1-TRX2) into the one tuned in step c and thereby supply to the receiver a frequency that causes the next received burst to be downconverted from the radio frequency channel to baseband;

e) repeating the steps b-d for each subsequent burst to be received.

3. A method according to claim 1 or 2 wherein the position to which the pointer is set in step b) is determined by the algorithm:

MAI = (FN + Z + MAIO) Modulo N

Where MAI denotes the position in the list (HFS), FN denotes a TDMA-frame number (F1-F5), Z denotes the timeslot number, MAIO denotes an offset and N denotes the

number of radio frequency channels (FCH1-FCH4) in the list (HFS).

4. A method according to claim 1 or 2 wherein the position to which the pointer is set is determined by the algorithm:

MAI = (FN + MAIO) Modulo N

where MAI denotes the position in the list (HFS), FN denotes a TDMA-frame number (F1-F5), N denotes the number of radio frequency channels (FCH1-FCH4) in the list (HFS) and MAIO denotes an offset and is given a specific value for each timeslot (TS) number.

5. A radio transmission system (BTS), for transmissions of radio bursts, including,

two frequency synthesizers (FS1,FS2) arranged to generate a high frequency,

a radio transmitter (TRX1-TRX2) with an input for receiving a stream of baseband bursts and an input from the two frequency synthesizers (FS1,FS2) and arranged to use the high frequency generated by an alternately of the two frequency synthesizers (FS1,FS2) to transform the stream of baseband bursts to a radio frequency channel (FCH1-FCH4),

means for storing a list (HFS) of radio frequency channels (FCH1-FCH4),

means (FHCT) for setting a pointer (MAI) to point at a position in the list and thereby select a first radio frequency channels (FCH1-FCH4) recorded at the position,

means for controlling an idle one of the two frequency synthesizers (FS1,FS2) to tune into a high

frequency corresponding to the first frequency channel (FCH1-FCH4),

c h a r a c t e r i s e d in that,

said means (FHCT) for setting the pointer (MAI) is arranged to set the pointer to a new position for each subsequent burst to be transmitted, and

said transmitter (TRX1-TRX2) is arranged to switch frequency synthesizer (FS11-FS22) for supply of high frequency for each of the bursts to be transmitted.

6. A radio transmission system (BTS) according to Claim 5, wherein said means for setting the pointer is arranged to set the pointer according to the method in claim 3.

7. A radio transmission system (BTS) according to Claim 5, wherein said means for setting the pointer is arranged to set the pointer according to the method in claim 4.

8. A radio receiving system (BTS), for receiving radio bursts in subsequent timeslots (TS), including,

two frequency synthesizers (FS1,FS2) arranged to generate a high frequency,

a radio receiver (TRX1-TRX2) with an input from an antenna for receiving a stream of radio bursts and an input from the two frequency synthesizers (FS1,FS2) and arranged to use the high frequency generated by an alternately of the two frequency synthesizers (FS1,FS2) to downconvert the stream of radio bursts to a stream of base band burst,

a list (HFS) of radio frequency channels (FCH1-FCH4),

means (FHCT) for setting a pointer (MAI) to point at a position in the list according to a predefined

algorithm and thereby determine a first radio carrier frequency (FCH1-FCH4) recorded at the position in which the stream of radio bursts will be received

means for controlling an idle one of the two frequency synthesizers (FS1,FS2) to tune into first radio carrier frequency,

c h a r a c t e r i s e d in that,

said means (FHCT) for setting the pointer (MAI) is arranged to set the pointer to a new position for each subsequent burst in the stream to be received, and

said receiver (TRX1-TRX2) is arranged to switch frequency synthesizer (FS11-FS22) for supply of high frequency at each shift of burst in the stream.

9. A radio receiving system (BTS) according to Claim 8, wherein said means for setting the pointer is arranged to set the pointer according to the method in claim 3.

10. A radio receiving system (BTS) according to Claim 8, wherein said means for setting the pointer is arranged to set the pointer according to the method in claim 4.

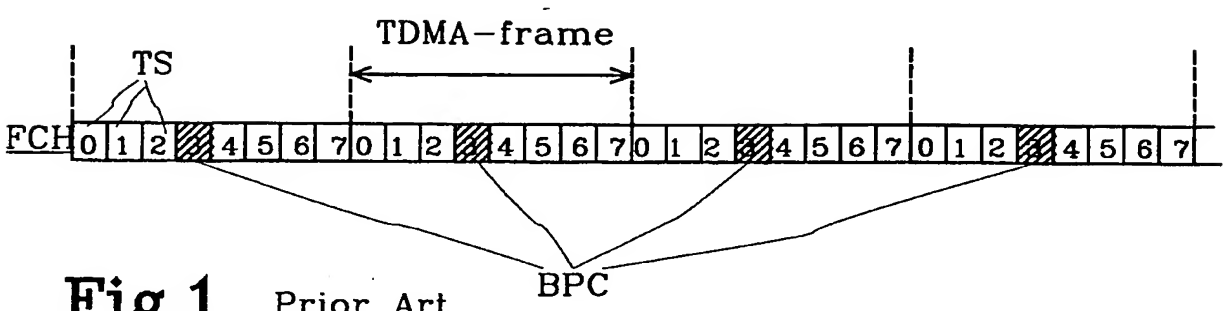

Fig.1 Prior Art

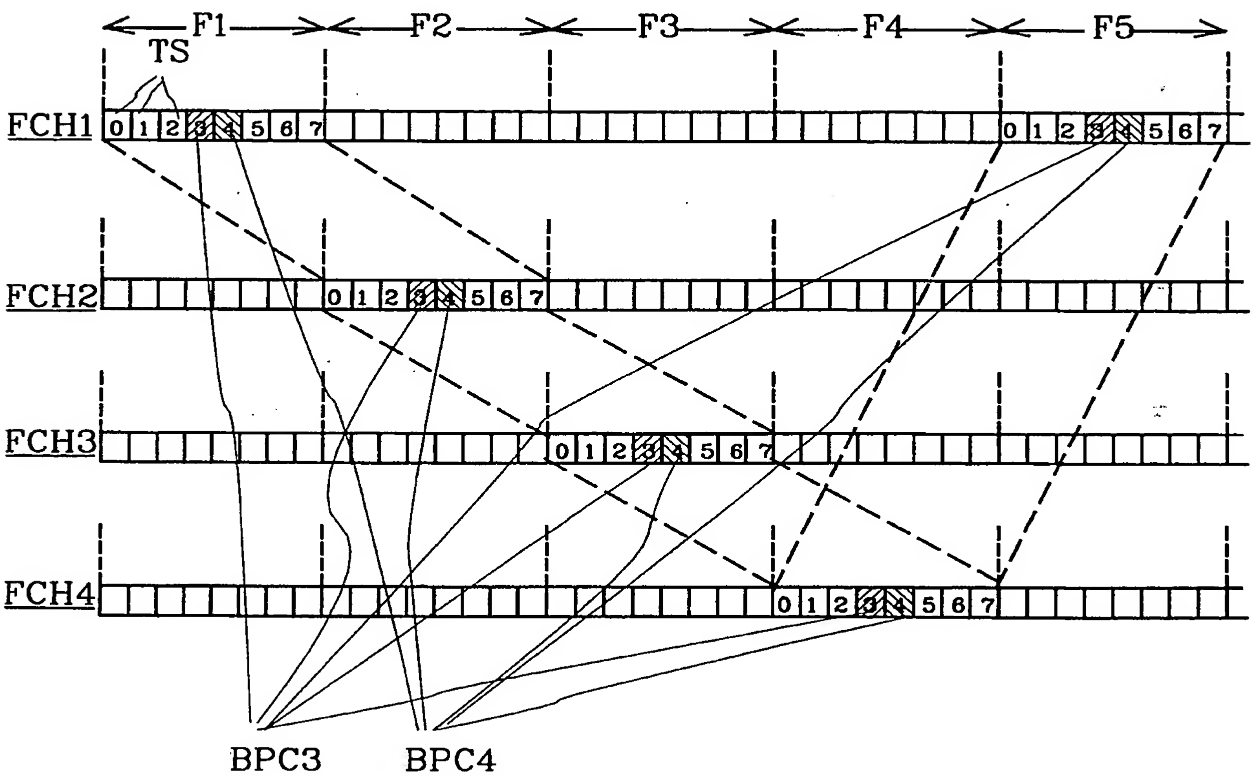

Fig.2 Prior Art

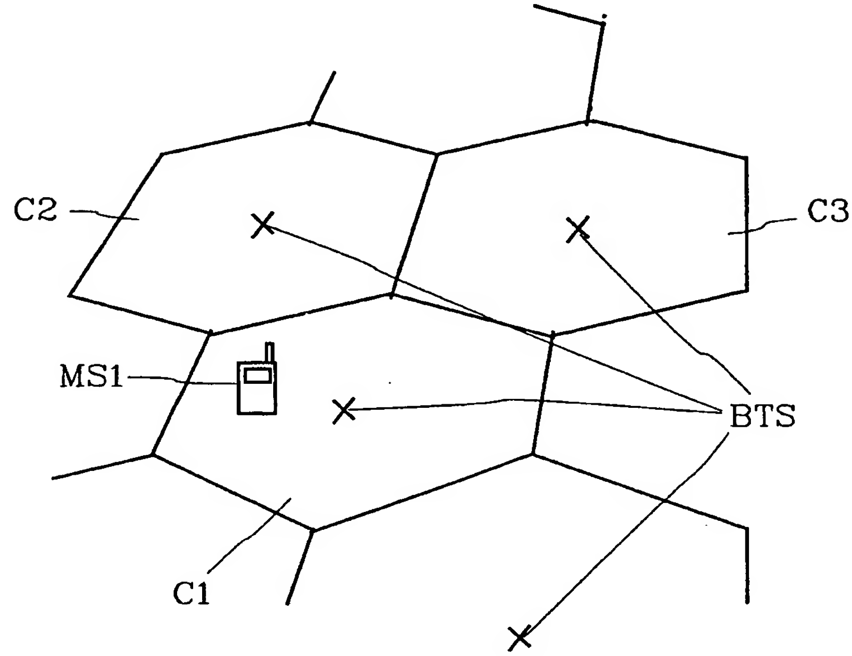

Fig.3 Prior Art

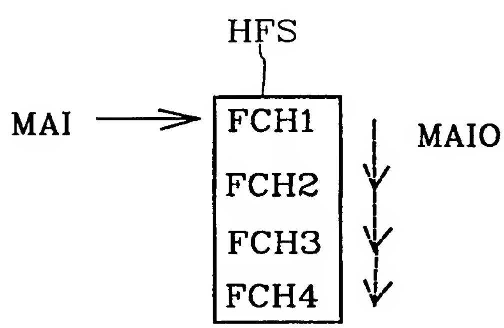

Fig.4 Prior Art

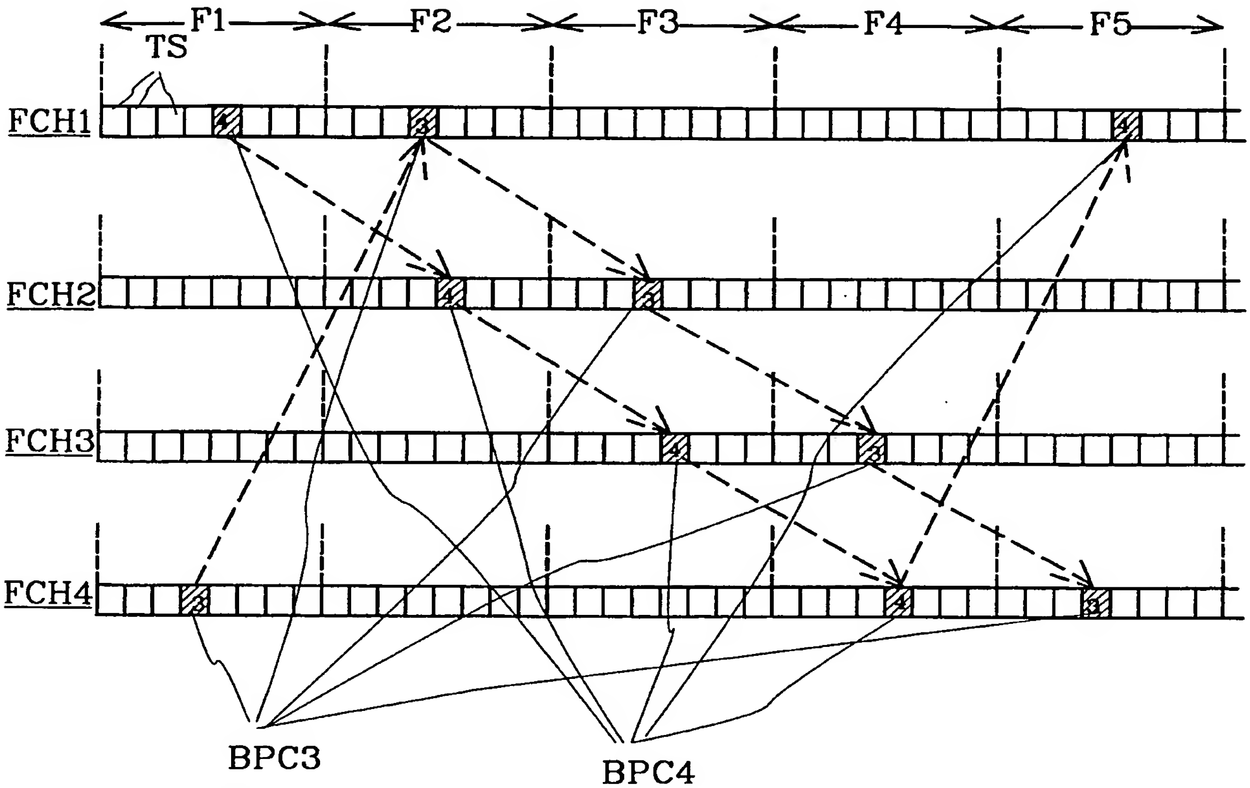

Fig.5

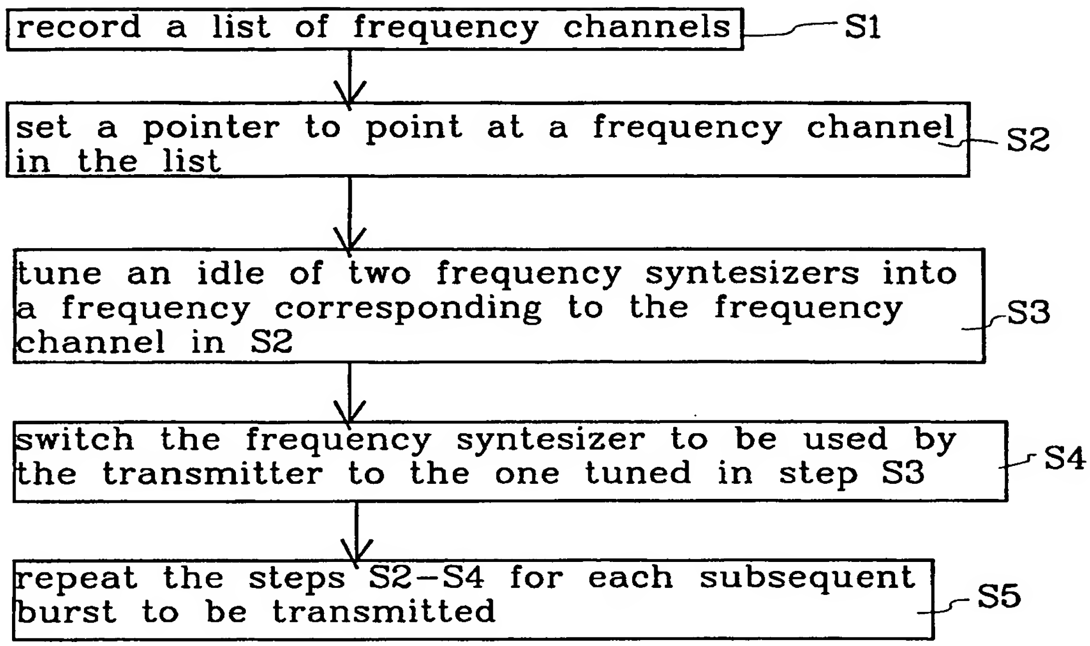
record a list of frequency channels
S1
set a pointer to point at a frequency channel in the list
S2
tune an idle of two frequency syntesizers into a frequency corresponding to the frequency channel in S2
S3
switch the frequency syntesizer to be used by the transmitter to the one tuned in step S3
S4
repeat the steps S2–S4 for each subsequent burst to be transmitted
S5

Fig.6

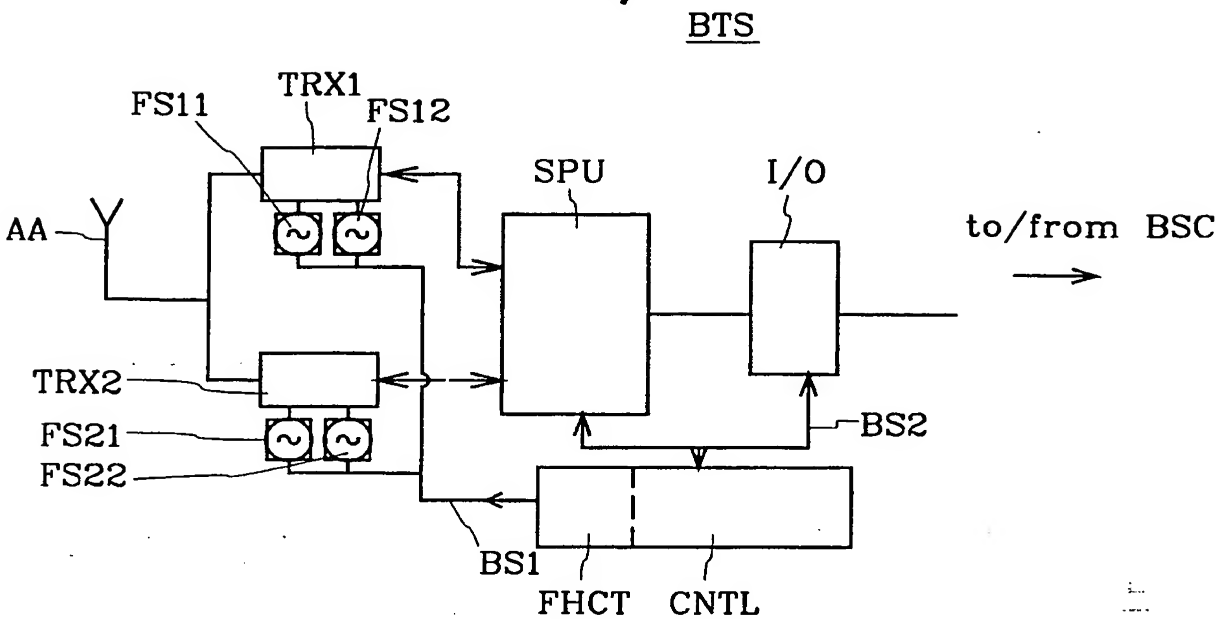
BTS
TRX1
FS11
FS12
SPU
I/O
to/from BSC
AA
TRX2
FS21
FS22
BS2
BS1
FHCT
CNTL

Fig.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/02693

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 1/04, H04Q 7/30
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5781582 A (SAGE, ET AL), 14 July 1998 (14.07.98), column 3, line 59 - column 5, line 38 --	1-10
A	US 5452290 A (MIHM JR.), 19 Sept 1995 (19.09.95), column 2, line 44 - column 3, line 13, figure 7 --	1-10
A	US 5648967 A (SCHULZ), 15 July 1997 (15.07.97), column 9, line 9 - line 49 --	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 March 2001	02-04-2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jaana Raivio/JAn Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/02693

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	IEEE Transactions on Vehicular Technology, November 1997 "Digital Frequency Synthesizer/Modulator for Continuous Phase Modulations with Slow Frequency Hopping" Vankka, Jouko Page 1039-1040 -- --------	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

05/02/01

International application No.

PCT/SE 00/02693

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		NO 954665 A	17/01/96
		US 5719857 A	17/02/98